Chemical sympatholysis: indications, technique and complications

Chemical sympatholysis is commonly performed for palmar or plantar hyperhidrosis, Buerger's disease, critical lower limb ischaemia where there is no revascularization option available and palliation of pain. The outcome varies from symptomatic improvement to failure, which may result in limb loss in the case of ischaemic limbs.

Sympathetic nerves are vasomotor to the smooth muscles of arterioles and pre-capillary sphincters, and secretomotor to the sweat glands. So decreasing the sympathetic activity is useful in hyperhidrosis and small vessel disease causing ischaemia of the extremities. Sympathetic nerves also act as afferents for pain sensations, which is exemplified by abolition of pain after chemical sympatholysis in complex pain syndromes and painful arterial ischaemias.

There are three ways of decreasing sympathetic drive to a particular area. They are surgical (open), chemical and regional drug-induced chemical sympatholysis. Open surgical sympatholysis has fallen out of favour because of associated morbidity, delay in resuming work, rare complications such as paraplegia and the availability of chemical and laparoscopic techniques. Chemical sympatholysis was first described by Brunn and Mandl in 1924 and has been used for peripheral vascular disease for at least 50 years. The results are comparable to open surgery (Courtheoux et al, 1982; Vulpio et al, 1989). Regional drug-induced sympatholysis using Bier's block shows an outcome that is comparable to surgical sympatholysis, however, there is a risk of sudden systemic toxicity from the medicine used. Thoracic chemical sympatholysis, clipping and thermal ablation of sympathetic ganglia are used for treating hyperhidrosis of the upper limbs and axilla and rarely for Raynaud's phenomenon. Lumbar chemical sympatholysis destroys both vasomotor and sensory fibres, resulting in the relief of ischaemic rest pain. This article reviews the indications, technique, effect and complications of chemical lumbar sympatholysis, which may be equally efficacious to surgical sympatholysis.

Indication for sympatholysis

Chemical sympatholysis is performed as a standalone procedure or as an adjunct to other procedures. The indications for sympatholysis are as follows. Although the long-term success rate is variable, the average immediate success rate is shown in brackets.

- Critical ischaemia of extremities where no further surgical option is available (35–100%)
- As an adjunct to limb amputation to hasten wound healing
- Buerger's disease (57%)
- Vasospastic attacks of the toes
- Palmo-plantar hyperhidrosis
- Sympathetic neuralgia
- Complex regional pain syndrome
- Causalgia following lumbar discectomy
- Palliation of abdominal pain from chronic pancreatitis or carcinoma of pancreas
- Erectile dysfunction related to increased cavernous adrenergic tone
- Neuropathic pain.

Technique

Thoracic or lumbar chemical sympatholysis may be performed under computed tomography (CT) or fluoroscopic guidance. Phenol is the most commonly used sympatholytic solution. Other solutions that are used for sympatholysis include ethyl alcohol and a mixture of phenol and glycerine. Two studies showed variable results with ethyl alcohol (Dolansky et al, 1990; Sukovatykh et al, 2006).

Initially, the procedure and risks should be explained to the patient. The patient should be positioned appropriately. The technique described here is for lumbar chemical sympatholysis. The two positions that are commonly used for chemical sympatholysis are lateral and sitting, although prone and semi-prone positions have also been described (Klopfer, 1983). The position should be comfortable for both the surgeon and the patient, and the sitting posture is commonly acceptable to all. A spinal needle or similar long needle is used. If the procedure is performed under fluoroscopy, a radio-opaque contrast is required to confirm the position of the tip of the needle.

The area should be cleaned with an antiseptic and draped (*Figure 1*). First, 15 ml of 1% plain lignocaine is infiltrated into the paraspinal region at the level of the L2 vertebra (from skin to retroperitoneum), then 7–10 ml of 5% oily phenol is mixed with 7–10 ml of omnipaque or a similar contrast. The needle is inserted at the level of the anterior border of the L2 vertebra – the solution should be injected into the retroperitoneal

Mr Rajaraman Durai *is Specialist Registrar and* **Mr Happy Hoque** *is Consultant General Surgeon in the Department of Surgery, Queen Mary's Hospital, Sidcup, Kent DA14 6LT*

Correspondence to: Mr R Durai

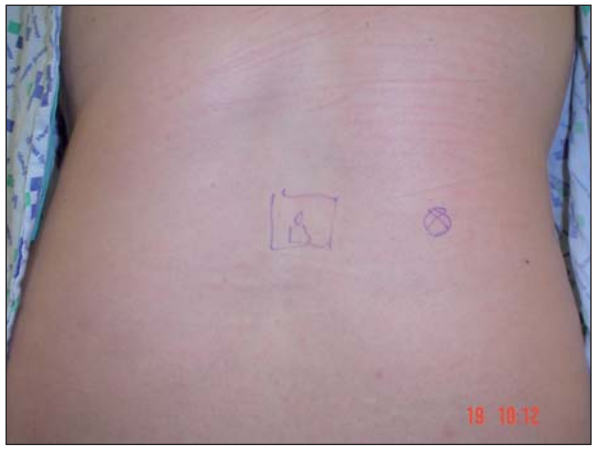


Figure 1. Surface marking for paraspinal chemical sympathetic injection at the level of L2 vertebra.

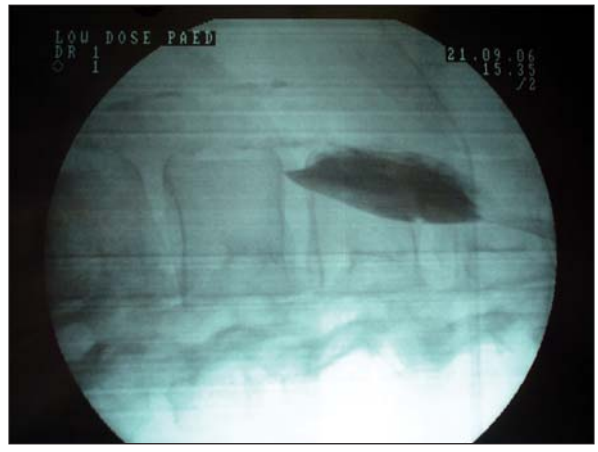


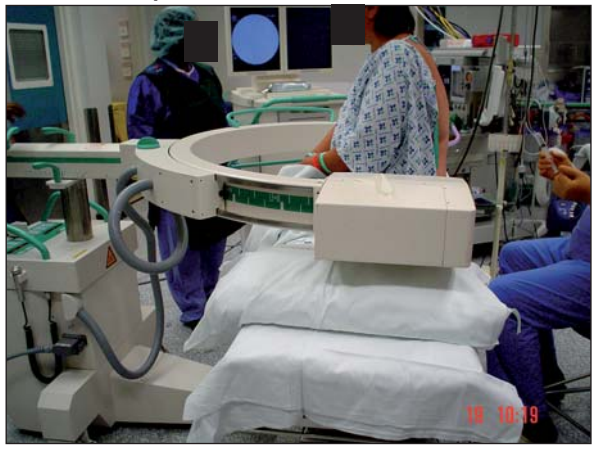
Figure 3. Injection of mixture of contrast material and oily phenol at the level of L2 vertebra to achieve chemical sympatholysis.

space under X-ray control (*Figures 2* and *3*). The aim is to achieve neurolysis of the sympathetic nervous system at L2, L3 and L4 levels. The injection should be localized to the retroperitoneum and should not enter the peritoneal cavity. Some surgeons advice the patient to sit up for a few hours post lumbar sympatholysis so that the chemical can track down along the sympathetic chain to achieve the desired effect. Sympatholysis may result with as little as 3 ml of phenol. For the CT-guided procedure 21G or 22G fine needles may be useful. Successful lumbar sympatholysis results in a rise in skin temperature in parts of the sock distribution of between 0.8 and 8.5°C when measured by thermography. The patient is observed for any complication and usually discharged home after 24 hours.

Complications

Complications of chemical sympatholysis can be avoided by careful planning. By always aspirating before injecting the phenol, it is possible to ensure that the needle is not inside the great vessels such as the inferior vena cava or aorta. Common complications of lumbar sympatholysis include compensatory hyperhidrosis, vasovagal attack and bleeding into the psoas muscle. Uncommon complications of lumbar sympatholysis include damage to the ureter and pelvi-ureteric junction disruption, transient neuralgia of the genitofemoral nerve, injury to blood vessels and spinal cord ischaemia.

Figure 2. The sitting position of the patient and the position of the C-arm which is kept horizontal.



Complications of thoracic sympatholysis include compensatory hyperhidrosis and vasovagal attack. Rare complications of thoracic sympatholysis include pneumothorax, brachial neuralgia, Horner's syndrome and injury to great vessels.

Chemical sympatholysis may be followed by compensatory and gustatory sweating. There are reports showing that chemical lumbar sympatholysis may result in ureteric necrosis requiring nephrectomy. The ureteric necrosis may be the effect of sympatholysis rather than the direct effect of phenol (Trigaux et al, 1992).

Discussion

Pathophysiological effects of sympatholysis

Chemical sympatholysis has been used for at least the last five decades. A PubMed search showed only one small randomized control trial on chemical sympatholysis comparing phenol with local anaesthetic. There were nine papers on the outcome of chemical sympatholysis (*Table 1*). Lumbar sympatholysis severs both vasomotor and sensory fibres (Coventry and Walsh, 2003). Doppler ankle pressure does not improve significantly after sympatholysis (Weyland et al, 1993), but most patients are relieved of rest pain. This may mean that there is no significant improvement in blood flow after sympatholysis. Chemical sympatholysis in these circumstances is probably acting as a pain-relieving injection by destroying fibres that carry pain sensation (Cross and Cotton, 1985).

Chemical sympatholysis improves perfusion in skeletal muscle and skin (Schneider et al, 1996). The outcome of chemical sympatholysis on ankle:brachial pressure index (ABPI) in normal individuals or those with an early form of arterial disease is not yet known. Chemical sympatholysis is often performed for irreconstructable arterial disease. The large vessels and microvasculature are usu-

ally diseased and often calcified. Sometimes the micro vessels may be maximally vasodilated by compensatory mechanisms such as autosympatholysis, so one should not expect the ABPI to improve in irreversible vascular disease. Sympatholysis may open up arteriovenous shunts rather than dilating arterioles. No substantial difference is found between the results of sympatholysis in diabetic and non-diabetic patients (Dolansky et al, 1990). Chemical sympatholysis has been used with success in patients with pain after lumbar discectomy presenting with causalgia. In causalgia, the patient experiences burning pain and hyperaesthesia in the distribution of an injured peripheral nerve. Selective use of chemical sympatholysis is certainly a useful procedure in palliating at least some critically ischaemic limbs and patients with chronic pain syndromes. Phenol should be injected away from the spinal cord and motor nerves because of the risk of flaccid paralysis.

Animal experiments show that sympatholysis also influences the major vessels. It causes migration of fibroblasts from the adventitia and migration or death of smooth muscle cells in vessels such as the femoral artery (Kacem and Sercombe, 2006; Kacem et al, 2006). Sympathetic nerves increase protein synthesis in oxidative skeletal muscles (Navegantes et al, 2004).

Endoscopic ultrasound may be useful in achieving neurolysis for pain related to pancreatic cancer. The relief of pain following coeliac ganglion sympatholysis in pancreatitis is 60–80% and in pancreatic cancer is 80–100% (Schneider et al, 1996).

Chemical sympatholysis

A small retrospective study (Lantsberg and Goldman, 1990) on 21 patients assessed the effect of chemical sympatholysis and found that there was subjective improvement in 20 patients, which was associated with increased cutaneous blood flow as measured by laser Doppler and transcutaneous oxygen tension techniques. Chemical sympatholysis improves cutaneous blood flow below knee level and may enhance primary wound healing in cases of below-knee amputation. CT-guided sympatholysis provides results similar to endoscopic thoracic sympatholysis and is associated with fewer risks (Horma Babana et al, 2004). Aqueous phenol solution is an effective and safe technique for neurolysis and ethanol neurolysis showed variable outcome.

The only published prospective double-blind trial was performed by Cross and Cotton (1985). Phenol chemical sympatholysis was compared with bupivacaine injection in 41 limbs (24 treatment and 17 control). Rest pain was relieved in 83.5% of patients at 1 week with a bupivacaine response of 23.5%. There was no demonstrable improvement in ABPI. Another showed insignificant increase in ABPI after chemical lumbar sympatholysis (Weyland et al, 1993).

Surgical lumbar sympatholysis *vs* chemical sympatholysis

Two studies compared the outcomes of surgical (open) lumbar sympatholysis *vs* chemical sympatholysis. In the smaller study there were 76 patients. The 6-week success

Table 1. Studies of chemical sympatholysis

Reference	Study	Details	Follow up	Outcome
Holiday et al (1999)	Surgical *vs* chemical sympatholysis	76 limbs of 70 patients with critically ischaemic lower limb	1 year	Limb salvage rates were 61% for surgical and 58% for chemical sympatholysis
Mashiah et al (1995)	Outcome of chemical lumbar sympatholysis	373 patients	Up to 10 years	In 58.7%, total relief from pain and healing of gangrenous ulcers
Romano et al (2002)	Computed tomography-guided thoracic sympathetic neurolysis	30 upper limbs in patients with palmar/ axillary hyperhidrosis	2 years	Two patients developed Horner's syndrome which later resolved, two patients developed pain in the arm which resolved, three patients developed compensatory sweating
Cross and Cotton (1985)	Randomized controlled trial of phenol chemical sympatholysis *vs* placebo bupivacaine	41 limbs (24 treatment and 17 control)	6 months	60% of patients remained free from rest pain
Becquemin et al (1989)	Chemical *vs* surgical lumbar sympatholysis	428 patients	1 month	Chemical sympatholysis had lower hospital stay and equally efficacious as surgery
Vulpio et al (1989)	Outcome of chemical lumbar sympatholysis	20 patients	2 years	52% limb salvage results
Dolansky et al (1990)	Outcome of chemical lumbar sympatholysis using ethanol	47 patients	6 months	In four fifths of patients limb ischaemia became worse
Alexander (1994)	Outcome of chemical lumbar sympatholysis	489 patients	2 years	44% lost either limb or life
Zhao et al (2003)	Treatment of Raynaud's syndrome with chemical thoracic sympatholysis	35 patients	9 months	66% obtained relief from symptoms
Horma Babana et al (2004)	Computed tomography-guided sympatholysis for palmar hyperhidrosis	101 limbs	50 months	62% effective. Six patients developed transient Horner's syndrome and six other patients developed compensatory hyperhidrosis

rate in 36 patients treated with surgical lumbar sympatholysis (44%) was better than in 40 patients treated with chemical lumbar sympatholysis (18%) (Holiday et al, 1999). However, the 1-year success rate was similar (47% for surgical and 45% for chemical lumbar sympatholysis). The 1-year limb salvage rates were also similar (61% for surgical and 58% for chemical lumbar sympatholysis). In the larger prospective study, 428 patients were assessed (Becquemin et al, 1989). The results of surgical and chemical sympathectomies were the same but hospital stay was 24 hours following chemical sympatholysis rather than 10 days following open sympatholysis. Sympatholysis in either form resulted in poor outcome when compared with arterial bypass.

Chemical lumbar sympatholysis for peripheral vascular disease

Four studies assessed the outcome of chemical lumbar sympatholysis for peripheral vascular disease. In the first study, phenol lumbar sympatholysis was performed on 373 patients, of whom 226 were diabetic. The patients were followed up for 10 years. A total of 219 patients experienced complete relief from pain and healing of gangrene or ischaemic ulcers. The treatment was unsuccessful in 154 patients (Mashiah et al, 1995). Diabetic patients with rest pain and non-diabetics with digital ulcer or gangrene responded to the treatment. Age did not influence the outcome. Heavy smokers did badly possibly because the vessels were badly damaged. The second small study on 20 patients, which assessed the effect of chemical sympatholysis on critically ischaemic limb, showed that it was useful in 50% (Vulpio et al, 1989).

A third study assessed the effect of 47 CT-guided transabdominal lumbar sympatholyses by ethyl alcohol in surgically inoperable lower extremity arteries (Dolansky et al, 1990). In four fifths of the patients there was an increase in ischaemia manifestations, but in one fifth there was no improvement. No substantial difference was found between the results of sympatholysis in diabetic and non-diabetic patients. In a large fourth study, a single author performed 544 chemical lumbar sympatholyses with phenol in 489 patients with peripheral vascular disease (Alexander, 1994). Although 72% of patients showed early symptomatic improvement, 44% suffered from either loss of limb or life within 2 years of sympatholysis.

KEY POINTS

- Chemical sympatholysis is useful in relieving pain in several complex pain syndromes.
- Chemical sympatholysis destroys both vasomotor and pain fibres.
- Chemical sympatholysis is useful in critical limb ischaemia when there is no revascularization option available.
- Ankle:brachial pressure index will not be improved by sympatholysis.

Thoracic sympathetic neurolysis

Three studies assessed the outcome of thoracic sympathetic neurolysis. In the first study, CT-guided injection of a 2–10 ml mixture of a solution containing phenol 8%, glycerine 20% and saline was administered with 22G needles into the paraspinal space at the T3 level through a paraspinal extrapleural approach (Romano et al, 2002). The sympatholysis was performed for palmar and axillary hyperhidrosis. The result was satisfactory in almost all patients – although there were few initial minor complications, at the end of 2 years there was 100% patient satisfaction. A second study assessed the effect of chemical sympatholysis for Raynaud's syndrome on 35 patients. A 2 ml injection of 5% phenol was administered to the second or third thoracic sympathetic ganglion (Zhao et al, 2003). Follow up at 9 months showed that it was 66% effective in relieving symptoms. The third study was a CT-guided sympatholysis for palmar hyperhidrosis on 101 limbs. It was 62% effective in 50 months. Six patients developed compensatory hyperhidrosis and six other patients developed transient Horner's syndrome. Thoracic chemical sympatholysis may be impossible when there are extensive pleural adhesions.

Conclusions

Chemical sympatholysis is useful in treatment of hyperhidrosis of the palms, axillae and soles. It is effective in palliating 50% of patients with an inoperable critically ischaemic foot. It may also be useful in Raynaud's phenomena and palliation of pain from carcinoma of pancreas and chronic pancreatitis. The current practice of chemical sympatholysis is based on limited evidence. Evidence from randomized controlled trials is required before recommending chemical sympatholysis either as a standalone procedure or as adjuvant to other vascular surgical procedures as a matter of routine. **BJHM**

The authors would like to thank Mr Frank Cross, Consultant Vascular Surgeon at the Royal London Hospital, London for kindly providing photographs and the patient who consented for publication of the photos.
Conflict of interest: none.

Alexander JP (1994) Chemical lumbar sympathectomy in patients with severe lower limb ischaemia. *Ulster Med J* **63:** 137–43
Becquemin JP, Kassab M, Bellouard A, Brugiere P, Melliere D (1989) [Lumbar sympathectomy in the aged subject: surgery or phenolization? Prospective study of early results]. *J Mal Vasc* **14:** 327–33
Courtheoux P, Theron J, Evrard C, Maiza D, Oriot G (1982) [Chemical lumbar sympathectomy: a new technic in therapeutic radiology]. *Ann Radiol (Paris)* **25**(6): 429–31
Coventry BJ, Walsh JA (2003) Cutaneous innervation in man before and after lumbar sympathectomy: evidence for interruption of both sensory and vasomotor nerve fibres. *ANZ J Surg* **73:** 14–18
Cross FW, Cotton LT (1985) Chemical lumbar sympathectomy for ischemic rest pain. A randomized, prospective controlled clinical trial. *Am J Surg* **150:** 341–5
Dolansky J, Metelka J, Sauer M (1990) [Results of transabdominal chemical sympathectomy of the lower extremities directed by computer tomography]. *Cesk Radiol* **44:** 278–81
Holiday FA, Barendregt WB, Slappendel R, Crul BJ, Buskens FG, van der Vliet JA (1999) Lumbar sympathectomy in critical limb

ischaemia: surgical, chemical or not at all? *Cardiovasc Surg* **7:** 200–2
Horma Babana H, Lucas A, Marin F, Duvauferrier R, Rolland Y (2004) [Evaluation of the efficacy of CT guided thoracic sympatholysis to treat palmar hyperhidrosis]. *J Radiol* **85:** 21–4
Kacem K, Sercombe R (2006) Differing influence of sympathectomy on smooth muscle cells and fibroblasts in cerebral and peripheral muscular arteries. *Auton Neurosci* **124:** 38–48
Kacem K, Sercombe C, Hammami M, Vicaut E, Sercombe R (2006) Sympathectomy causes aggravated lesions and dedifferentiation in large rabbit atherosclerotic arteries without involving nitric oxide. *J Vasc Res* **43:** 289–305
Klopfer GT (1983) Neurolytic lumbar sympathetic blockade: a modified technique. *Anaesth Intensive Care* **11:** 43–6
Lantsberg L, Goldman M (1990) Lower limb sympathectomy assessed by laser Doppler blood flow and transcutaneous oxygen measurements. *J Med Eng Technol* **14:** 182–3
Mashiah A, Soroker D, Pasik S, Mashiah T (1995) Phenol lumbar sympathetic block in diabetic lower limb ischemia. *J Cardiovasc Risk* **2:** 467–9
Navegantes LC, Resano NM, Baviera AM, Migliorini RH, Kettelhut IC (2004) Effect of sympathetic denervation on the rate of protein synthesis in rat skeletal muscle. *Am J Physiol Endocrinol Metab* **286:** E642–7
Romano M, Giojelli A, Mainenti PP, Tamburrini O, Salvatore M (2002) Upper thoracic sympathetic chain neurolysis under CT guidance. A two year follow-up in patients with palmar and axillary hyperhidrosis. *Radiol Med (Torino)* **104:** 421–5
Schneider B, Richter GM, Roeren T, Kauffmann GW (1996) [CT-guided neurolysis. Status of the technique and current results]. *Radiologe* **36:** 692–9
Sukovatykh BS, Itinson AI, Belikov LN, Sukhovatykh MB (2006) [Lumbar chemical sympathectomy in complex treatment of critical impairments of microcirculation in patients with decompensated forms of chronic venous insufficiency]. *Vestn Khir Im I I Grek* **165:** 95–7
Trigaux JP, Decoene B, Van Beers B (1992) Focal necrosis of the ureter following CT-guided chemical sympathectomy. *Cardiovasc Intervent Radiol* **15:** 180–2
Vulpio C, Borzone A, Iannace C et al (1989) Lumbar chemical sympathectomy in end stage of arterial disease: early and late results. *Angiology* **40:** 948–52
Weyland A, Weyland W, Lamersdorf A, Ensink FB, Hildebrandt J, Kettler D (1993) [Neurolytic block of the lumbar sympathetic trunk in advanced stages of peripheral arterial occlusive disease]. *Anasthesiol Intensivmed Notfallmed Schmerzther* **28:** 420–6
Zhao J, Dong GX, Luan JY (2003) [Experience in treatment of Raynaud's syndrome by chemical thoracic sympathectomy]. *Zhonghua Yi Xue Za Zhi* **83:** 1943–5